[Claims]

1. A mobile device which has a health care function based on biomedical signals and includes an input unit, a display unit, a memory unit and a central control unit, the mobile device comprising:

a biomedical signal measurement module for detecting biomedical signals from a user's body, classifying the detected biomedical signals by respective signals and outputting the classified signals; and

a health care module for analyzing a user's emotional state and physical condition based on the classified signals input from the biomedical signal measurement module and user's physical information.

2. The mobile device as claimed in claim 1, wherein the biomedical signal measurement module comprises:

a sensor unit for detecting one or more biomedical signals from the user's body; and

a sensor control unit for controlling the sensor unit, classifying the biomedical signals input from the sensor unit by the respective biomedical signals and outputting the classified biomedical signals.

3. The mobile device as claimed in claim 2, wherein the sensor unit comprises a heart rate sensor for detecting heartbeat-related biomedical signals.

4. The mobile device as claimed in claim 3, wherein the biomedical signals of heartbeat are PPG signals.

5. The mobile device as claimed in claim 2, wherein the sensor unit comprises a skin temperature sensor for detecting skin temperature-related biomedical signals.

6. The mobile device as claimed in claim 5, wherein the biomedical signals of skin temperature are SKT signals.

7. The mobile device as claimed in claim 2, wherein the sensor unit comprises a skin resistance sensor for detecting skin resistance-related biomedical signals.

8. The mobile device as claimed in claim 7, wherein the biomedical signals of skin resistance are EDA signals.

9. The mobile device as claimed in claim 2, wherein the sensor unit comprises a body fat sensor for measuring body impedance required for calculation of a body fat percentage.

10. The mobile device as claimed in any one of claims 3, 5, 7 and 9, wherein each of the heart rate sensor, skin temperature sensor, skin resistance sensor and body fat sensor comprises a filter for filtering the detected biomedical signals and an amplifier for amplifying the filtered biomedical signals.

11. The mobile device as claimed in any one of claims 3, 5, 7 and 9, wherein each of the heart rate sensor, skin temperature sensor, skin resistance sensor and body fat sensor is installed at a position on the mobile device with which user's hand comes into contact when the user holds the mobile device.

12. The mobile device as claimed in claim 2, wherein the sensor control unit corrects user-to-user variation of the biomedical signals which are output from the sensor unit.

13. The mobile device as claimed in claim 1, wherein the biomedical signal measurement module is constructed to be detachably coupled to the mobile device.

14. The mobile device as claimed in claim 13, wherein the biomedical signal measurement module is constructed in the form of a case capable of accommodating the mobile device therein.

15. The mobile device as claimed in claim 1, wherein the health care module comprises:

an emotional state analysis unit for analyzing the biomedical signals input from the biomedical signal measurement module and determining the user's emotional state; and

a physical condition analysis unit for analyzing the user's physical condition based on the biomedical signals input from the biomedical signal measurement module and the user's physical information.

16. The mobile device as claimed in claim 15, wherein the emotional state analysis unit comprises:

a feature analysis unit for analyzing features of the biomedical signals detected from the user's body;

a subtracter unit for obtaining differences between the analysis results from the feature analysis unit and feature values on which the user's emotional state is determined based; and

a support vector machine (SVM) unit for analyzing the differences of the feature values obtained by the subtracter unit, classifying the user's emotional state, and calculating and outputting an index and level for a specific emotion among the classified emotions.

17. The mobile device as claimed in claim 16, wherein the feature analysis unit comprises:

a heartbeat analysis unit for receiving PPG signals to detect heartbeat signals and extracting feature values related to the heartbeat signals;

a skin conductive response analysis unit for receiving EDA signals and extracting feature values related to a skin conductive response; and

a skin temperature analysis unit for receiving SKT signals and extracting feature values related to skin temperature.

18. The mobile device as claimed in claim 17, wherein the heartbeat analysis unit comprises:

a heartbeat detection unit for receiving the PPG signals to detect the heartbeat signals and converting the detected heartbeat signals into time series signals of heart rate variability;

a spectrum analysis unit for analyzing a spectrum of the heartbeat signals in response to the time series signals of the heart rate variability; and

a mean/standard deviation calculation unit for calculating a mean value and standard deviation value of the heartbeat signals in response to the time series signals of the heart rate variability.

19. The mobile device as claimed in claim 18, wherein the heartbeat detection unit comprises:

a band pass filter for extracting signals falling within a specific band of the PPG signals;

a median filter for removing noise existing in the filtering results of the band pass filter;

an adder for calculating a difference between the filtering results of both the band pass filter and the median filter by adding a reciprocal number of the filtering result of the median filter to the filtering result of the band pass filter;

a matched filter for extracting the heartbeat signals from output signals of the adder; and

a zero clipper for performing zero clipping for the heartbeat signals.

20. The mobile device as claimed in claim 16, wherein the subtracter unit uses feature values of a user's normal emotion as the feature values on which the user's emotional state is determined based.

21. The mobile device as claimed in claim 16, wherein the SVM unit comprises:

an SVM classifier for classifying the user's emotional state into a plurality of categories by analyzing the differences of the features values obtained from the subtracter unit; and

an emotional state determination unit for selecting values related to the specific emotion among values of the plurality of emotions classified by the SVM classifier and calculating and outputting the index and level for the specific emotion.

22. The mobile device as claimed in claim 21, wherein the SVM unit further comprises:

a database for storing a plurality of pieces of emotion data for training the SVM classifier, and trained results of the SVM classifier based on the emotion data.

23. The mobile device as claimed in claim 15, wherein the physical condition analysis unit comprises:

a body fat percentage calculation unit for calculating body fat percentage based on a body impedance value detected by the biomedical signal measurement module and user's height, weight, age and sex; and a calorie consumption calculation unit for calculating calorie consumption due to exercise based on average heart rates and body fat percentages before/after exercise detected by the biomedical signal measurement module.

24. A health care method using a mobile device, comprising the steps of:

selecting, by a user, a health care menu on a mobile device with a biomedical signal measurement module;

if the user selects emotional state measurement, activating the biomedical signal measurement module to detect the biomedical signal in the mobile device;

detecting at least one biomedical signal from a user's body;

analyzing the detected biomedical signals and extracting a plurality of feature values to be used for determining user's emotional state;

calculating differences between the plurality of extracted feature values and feature values on which the user's emotional state is determined based;

classifying the user's emotional state by respective emotions based on SVM classification according to the calculated differences of the feature values; and

selecting values related to an emotion selected among the classified emotions, calculating an emotional state index and level for the selected emotion, and displaying the calculated emotional state index and level on a display unit of the mobile device.

25. The method as claimed in claim 24, wherein the biomedical signals detected from the user's body include biomedical signals of heartbeat.

26. The method as claimed in claim 25, wherein the biomedical signals of heartbeat are PPG signals.

27. The method as claimed in claim 24, wherein the biomedical signals detected from the user's body include skin temperature-related biomedical signals.

28. The method as claimed in claim 27, wherein the biomedical signals of skin temperature are SKT signals.

29. The method as claimed in claim 24, wherein the biomedical signals detected from the user's body include skin resistance-related biomedical signals.

30. The method as claimed in claim 29, wherein the biomedical signals of skin resistance are EDA signals.

31. The method as claimed in claim 24, wherein the biomedical signals detected from the user's body are filtered by a filter and then amplified by an amplifier.

32. The method as claimed in claim 24, further comprising the step of correcting user-to-user variation of the biomedical signals detected from the user's body.

33. The method as claimed in claim 32, wherein the step of correcting the user-to-user variation of the biomedical signals comprises the steps of:

determining whether the user's body is in contact with the biomedical signal measurement module;

if it is determined that the user's body is in contact with the biomedical signal measurement module, determining whether the correction of the user-to-user variances of the detected biomedical signals is required;

if it is determined that the correction of the user-to-user variances of the detected biomedical signals is required, checking whether values of the detected biomedical signals are above a maximum limit level and decreasing a gain of an amplifier if the values of the detected biomedical signals are above the maximum limit level; and

if the values of the detected biomedical signals are equal to or less than the maximum limit level, checking whether the values of the detected biomedical signals are equal to or less than a minimum limit level and increasing the gain of the amplifier if the values of the detected biomedical signals are equal to or less than the minimum limit level.

34. The method as claimed in claim 24, wherein the step of analyzing the biomedical signals and extracting the plurality of feature values to be used for determining the user's emotional state comprises the steps of:

receiving PPG signals to detect heartbeat signals and extracting feature values related to the heartbeat signals;

receiving EDA signals and extracting feature values related to a skin conductive response; and

receiving SKT signals and extracting feature values related to skin temperature.

35. The method as claimed in claim 24, wherein the feature values on which the user's emotional state is determined based are feature values of user's normal emotion.

36. The method as claimed in claim 24, wherein the step of classifying the user's emotional state by the respective emotions uses an SVM classifier that classifies the user's emotional state into a plurality of categories based on a statistical learning theory.

37. The method as claimed in claim 24, wherein the biomedical signal measurement module is configured to be detachably coupled to the mobile device.

38. The method as claimed in claim 37, wherein the biomedical signal measurement module is constructed in the form of a case capable of accommodating the mobile device therein.

39. The method as claimed in claim 24, further comprising the steps of, if the user selects body fat measurement,

activating a body fat sensor in the biomedical signal measurement module mounted to the mobile device;

measuring body impedance from the user's body by the body fat sensor; and

calculating a body fat percentage of the user's body based on the measured impedance and user's physical information and displaying the calculated the body fat percentage on the display unit.

40. The method as claimed in claim 24, further comprising the steps of, if the user selects calorie consumption measurement,

activating a heart rate sensor and a body fat sensor in the biomedical signal measurement module;

measuring heartbeat signals and body impedance before/after exercise from the user's body by the heart rate sensor and the body fat sensor; and

analyzing the heartbeat signals and the body impedance before/after exercise to calculate average heart rates and body fat percentages before/after exercise, calculating calorie consumption due to exercise based on the calculated average heart rates and body fat percentages before/after exercise, exercise time, and user's physical information, and displaying the calculated calorie consumption on the display unit.

41. The method as claimed in any one of claims 27, 39 and 40, further comprising the step of, if the user selects history management, displaying measurement results according to respective desired terms on the display unit.